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RECYCLING HUMAN WASTE:

COMPOSTING TOILETS AS A REMEDIAL

ACTION IN HAMILTON HARBOUR

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Conclusion

Nous avons examiné sous divers aspects l'utilisation des toilettes à compostage comme mesure permettant d'améliorer la qualité de l'eau dans le port de Hamilton. Même si seulement 10 % des ménages de la région de Hamilton/Burlington utilisaient des toilettes à compostage, il y aurait une réduction considérable des charges de substances nutritives se retrouvant dans les stations municipales d'épuration des eaux usées et dans le port. La quantité d'azote se retrouvant dans le réseau d'égouts serait réduite de 270 tonnes par année et la quantité de phosphore serait réduite de 90 tonnes par année. Les toilettes à compostage permettraient aussi d'économiser l'eau de façon appréciable.

Du point de vue de la technique et de l'économie, les toilettes à compostage ne sont ni parfaites ni bon marché; il en va souvent ainsi des nouvelles techniques. Les premières automobiles, par exemple, comportaient des défauts mécaniques et seuls les gens riches pouvaient en acheter. La même chose s'est produite avec les ordinateurs. Au fur et à mesure que ces nouvelles techniques se sont généralisées, leur rendement s'est amélioré et leur prix a baissé. En consultant la documentation, on s'aperçoit que le rendement des toilettes à compostage a déjà commencé à s'améliorer. Les nouveaux modèles sont beaucoup plus efficaces que ceux des années 70 et du début des années 80. Les toilettes à compostage continuent de coûter plus cher que les toilettes avec chasse d'eau, mais, en vertu des économies d'échelle, leur prix diminuera probablement considérablement à mesure que leur utilisation se répandra dans la population.

Pour ce qui est de l'accueil que leur réserve le public, les résultats de l'enquête indiquent que près d'un quart des propriétaires de maison de la région de Hamilton/Burlington accepteraient d'installer des toilettes à compostage dans leur maison; 26 % refuseraient, et 51 % sont indécis. Une partie de ces derniers accepteraient sans doute d'en installer s'ils étaient mieux renseignés. L'accueil fait aux toilettes à compostage est fortement et directement lié au degré d'intérêt que portent les gens à l'environnement. Les personnes qui se soucient davantage de l'environnement sont plus susceptibles d'essayer les toilettes à compostage. Il s'agit là d'un lien très encourageant car, à l'avenir, il est probable que le public continuera de s'intéresser beaucoup à l'environnement.

Recommandation

On recommande de mettre en oeuvre aussitôt que possible un projet de démonstration de l'utilisation des toilettes à compostage. La démonstration pourrait avoir lieu dans l'une des zones critiques, grâce à un groupe de volontaires. Il s'agirait de conclure un accord avec chaque personne, stipulant qu'elle recevrait des toilettes à compostage (gratuitement ou contre une somme nominale) à la condition d'accepter de participer au projet pendant une période donnée (un ou deux ans). Les volontaires tiendraient un registre du rendement de l'appareil ainsi que des réactions de leur famille, de leurs voisins ou des visiteurs. Un projet comme celui-là permettrait d'atteindre plusieurs objectifs. Il permettrait d'évaluer la viabilité des toilettes à compostage en milieu urbain (à l'heure actuelle, elles sont surtout utilisées en milieu rural). Le projet aurait aussi un but éducatif, visant non seulement les participants, mais aussi le grand public par l'intermédiaire des reportages des médias.

Introduction

The purpose of this project was to explore the technical and economic feasibility, and the social acceptability of composting toilets in the Hamilton-Burlington area. The idea was a response to calls by the International Joint Commission and its Water Quality Board and Science Advisory Board for new and innovative solutions to water quality problems in the Great Lakes basin. We chose Hamilton Harbour as our study area because we perceive an acute need for some new strategies in this Area of Concern.

We approached our investigation from three angles: 1) research on what types of composting toilets are available, how they work, and their cost; 2) a survey of owners of composting toilets to get an appreciation of potential problems with their use; and 3) a survey of homeowners in the Hamilton-Burlington area to gauge social acceptability.

Background

Hamilton Harbour is a bay located at the western tip of Lake Ontario. It is surrounded by an urban area of approximately 500,000 people, composed of several municipalities: Hamilton; Burlington; Stoney Creek; Dundas; Ancaster; and Flamborough. It is also the site of two major steel companies and other industries.

A Remedial Action Plan (RAP) is being developed for Hamilton Harbour. A team of engineers and scientists (the RAP team) is studying the water quality and ecosystem quality problems of the area, and has developed a list of remedial options which would improve the situation. A group of citizens representing a wide range of sectors of the community, the Hamilton Stakeholders Group, has developed goals for the Harbour, and principles to guide remedial actions directed at achieving those goals.

One basic problem is that the best available technology (BAT) at the sewage treatment plants is very expensive and may not be sufficient to achieve all of the stakeholders' goals for the harbour. Although the concentration of phosphorus and nitrogen in the sewage treatment plant effluents can be reduced to very low levels, the total load will still result in a eutrophic harbour because of the 500,000 people who live in the area and the relatively small size of the bay. Hamilton Harbour needs zero discharge of nutrients, or very close to zero in order to recover from eutrophication.

Another option which has been proposed is the construction of a pipe to Lake Ontario, so that sewage treatment plant effluent (after treatment) could be discharged directly to the lake, and not to the Harbour. This alternative was strongly opposed by the stakeholder group and by citizens who attended a public meeting. The reasons underlying this opposition are not entirely clear, and they are likely different for different individuals. Some people want the Best Available Technology (BAT) applied first, and then

they might consider diversion to Lake Ontario if BAT was not enough to clean up the harbour. Others feel that this option violates their basic principles of the ecosystem approach, zero discharge, and control of pollution at the source. They do not want to clean up the Harbour at the expense of Lake Ontario. Another reason is concern about safeguarding the drinking water supply for the area, which comes from Lake Ontario.

We thought: there must be other choices here. There must be other ways to keep phosphorus and nitrogen out of the harbour. Thus, the composting toilet project was conceived. Composting toilets are consistent with many of the stakeholders principles. They tackle pollution at its source; they will discharge no pollutants to the harbour (zero discharge); and they are a step towards a more sustainable way of life. We are not suggesting that composting toilets are "the" solution, but rather that they might be part of a sustainable solution. Cities will still need water supply systems and wastewater treatment plants, but if a portion of the population used composting toilets, there would be less wear and tear on existing water infrastructure, less need for expansion, and there would be savings in energy, as well as water quality benefits.

Composting toilets are an alternative that deserves consideration. They may sound a bit far-fetched in the context of our twentieth century North American culture, but ecologically they make sense. Ten years ago recycling of cans and bottles was labelled "impractical", and dismissed as not viable because of the assumption that people would not do it. Now a large percentage of the population in the Hamilton-Burlington area regularly participates in recycling. During the first four months of 1989, citizens in the Hamilton area recycled 11.5% of their municipal solid waste. In Burlington, about 16% of the solid waste was recycled in 1989.

Flush Toilets and Water Pollution

Jack Vallentyne, in his book The Algal Bowl (1), points out the historical link between the invention of flush toilets and centralized sewage collection systems, and the pollution of our rivers and lakes. The practice of putting sewage into water breaks the natural land-based cycle whereby the waste from animals (including humans) is broken down into nourishment for plants. Once the phosphorus and nitrogen from sewage is discharged into the lakes, there is no natural mechanism for those nutrients to get back to the land where they are needed. They remain in the water, overfertilizing the aquatic system, accelerating eutrophication.

Potential Benefits of Composting Toilets

Each year the average person produces about 5.4 kilograms of nitrogen, 1.8 kilograms of phosphorus, and 1.4 kilograms of

potassium (dry weight). If 10 % of the population in the Hamilton/Burlington area were to use composting toilets, there would be a substantial reduction in nutrient loadings to the municipal sewage treatment plants, and to the harbour. Nitrogen entering the sewage system would be reduced by 270 tonnes per year, phosphorus would be reduced by 90 tonnes per year, and potassium would be reduced by 70 tonnes per year.

Composting toilets would also generate significant benefits in the area of water conservation. The average daily discharge of toilet water into the sewage system is 103 litres per person per day. If 10 percent of the Hamilton/Burlington population used composting toilets (which require no water), approximately 2 billion litres of water could be conserved annually. This would result in savings to individual households on their water and sewage bills as well as a reduction in the infrastructure required to deliver water to and collect sewage from homes, and savings in energy required.

Technical and Economic Aspects of Composting Toilets

Composting toilets are a form of decentralized waste treatment, as opposed to the centralized systems now in operation in most urban areas. This means that the waste is treated on site, close to its source, rather than being transported to a central location for treatment.

Composting is a process in which the microbial breakdown of organic material takes place in the solid phase. Composting can proceed anaerobically (without oxygen), aerobically (with oxygen), or in a combination of the two processes. Composting toilets are designed to facilitate aerobic decomposition of the waste. In general, anaerobic composting proceeds slowly and gives off only a small amount of heat. The end products are odourous compounds such as methane and hydrogen sulphide. Aerobic composting is quite different. It proceeds at a faster rate, releases more heat, and does not produce offensive odours. The breakdown of organics is much more complete in the aerobic process, with the main end products being carbon dioxide and water (2).

Small composting toilets are designed to fit in an average bathroom. They use electric heating coils and forced ventilation (with a fan) to promote the rapid decomposition of waste. The heating coils located in the waste storage area maintain an optimum temperature (35 to 40 degrees Celsius), and the process is kept aerobic by air intakes at the bottom of the unit and a draft fan installed in a draft tube connected to a roof vent. The theory behind this design is that, by providing an ideal environment for the microbial process, the waste can be stabilized in a relatively short time, and the size of the composting unit can be kept small. Installation is relatively easy since they sit on the floor and require only an exhaust vent and a power source (2).

The feed material for a composting toilet includes human body wastes, bulking agent (i.e. peat moss, kitchen, garden, or lawn scraps) that must be added periodically, and all naturally occurring organisms which live in these materials. Oxygen, mixing, energy, ventilation, and time to complete the evaporation and allow some degree of biological decomposition are all provided in the toilet structure. The humus-like end product, once the reaction has been allowed enough time, resembles soil in appearance and odor and contains reduced levels of pathogens (4). It can be used as a soil conditioner and fertilizer for shrubs and flower beds.

Some concerns have been raised in the literature about the use of the end-product of composting toilets on vegetable gardens. In one American study the end products of poorly operating biological toilets showed positive results in screening tests for specific pathogens, parasitic, bacterial, and viral (3). However, systems which were working as intended did not contain pathogenic bacteria or viruses, but were found to occasionally exhibit positive samples for parasites (4). Another study (5) noted that parasites would be the only form of pathogen likely to survive a lengthy period in a biological toilet. However, parasites would only be present in the compost if the people using the toilet had them in their systems. A recent test of a 1989 model composting toilet carried out by the National Sanitation Foundation measured the fecal index of the end product of the toilet. The requirement was that it be less than 200 MPN/gm, and the actual level was 27. It would seem that composting toilet technology is improving.

A major problem in getting early composting toilets to work properly was excess moisture. Human body wastes average 90 percent liquids and 10 percent solids. Without a bulking agent and the evaporation of excess moisture, biological action might become anaerobic.

The small composting toilets (with fans and heating coils) are reported to function well under normal conditions. However, they can be upset by organic and liquid shock loadings. Problems occur if there is an excessive input of urine, because this can saturate the compost and prevent oxygen penetration. Consequently, the composting process switches from the desirable aerobic process to an undesirable anaerobic process. This produces unpleasant odours in the home, and once the toilet has become anaerobic, it usually requires considerable time to reestablish aerobic conditions.

Under-used toilets generally do not have problems as long as the compost is moist enough to keep the microbial populations alive. If the compost dries out the microbial action slows or stops.

A few studies have been done to evaluate the performance of composting toilets in the field. An EPA study of 32 waterless

toilets in California (8 of which were small composting types), reported that most of the units did not work very well. "Few of these systems displayed any significant evidence of biological composting during 17 months of observation. The systems repeatedly showed evidence of conditions unfavorable for the occurrence of biological composting--for example, inadequate use of bulking agent, too much moisture, anaerobic conditions, insects, and ambient (too low) temperatures. The users were generally not well informed about the particular sensitivities of their systems to improper operating procedures" (3). The report cited poor design of the toilets as well as improper operation and maintenance on the part of the owners as reasons for the toilets' failure to work properly. These types of problems are typical of new technologies.

In the early 1970's, a composting toilet under the brand name Humus was introduced as part of a program to deal with sewage disposal at the Big Trout Lake and Sandy Lake Indian Reserves in northern Ontario (6). Fifteen composting toilets were installed, 8 in residences, 6 in the two nursing stations, and one in an operations building. The toilets were installed in January and results were reported at a meeting in April. The toilets at the nursing stations were all reported to be exhibiting problems. The reason for this failure was likely a design problem. In general, composting toilets can not handle a large number of users per toilet. The liquids cannot be evaporated quickly enough, and the process becomes anaerobic. Of the composting toilets installed in homes, some were reported to be working satisfactorily (7). Conclusions in this study were that the key to success was proper social acceptance of these toilets and the commitment of the users to operate the toilets according to instructions.

Another article (4) discusses the results of several laboratory and field tests of composting toilets in North America and Europe. Most units failed the tests initially, but designers learned from the experience and were able to correct many of the technical shortcomings of the earlier models. A major improvement is the greater evaporative capacity of the newer composting toilets. However, the authors point out that the new designs still require knowledgeable operation and also require significantly increased power. For example, if the Scandinavian-certified toilet for 5 people is employed at capacity, the fan and heater would be expected to use about 6 kwh of electricity per day. The owner would be expected to empty a chamber every three months and provide continuous addition of bulking agent. Another factor is that the capacity for temporary overloads due to social occasions is limited (4).

A Canadian composting toilet, the Sun-Mar Bowli-XL, was recently tested by the National Sanitation Foundation in Ann Arbor, Michigan, and found to have satisfied the requirements of the NSF Standard 41: Wastewater Recycle/Reuse and Water Conservation Devices (8). The solid end product of the toilet had a fecal index

of 27 MPN/gm (the requirement was that it be less than 200 MPN/gm). The moisture content was 9.4% (compared with a requirement of less than 75%). There were also no odours associated with the end product, at the bowl, or at ground level downwind of the vent pipe. These positive results are very encouraging.

In order to place the negative reports on early composting toilets into perspective, it might be appropriate to recall early experiences with the automobile. The early cars didn't work right either. They were hard to start, they had lots of flat tires, they were difficult to operate, and they were expensive. Many new technologies go through a period of trial and error when they are first introduced, and from our review of the literature on composting toilets, this seems to be what has happened during the 70's and 80's. Composting toilets will probably never be as simple to operate as flush toilets, but the new models do work for owners who are sensitive to the needs and limitations of the composting process.

In addition to the electricity required to run the fan and heater, the capital cost of a composting toilet must be considered. At the writing of this report, composting toilets in Canada are priced at $1200 to $1500. This is considerably higher than a conventional flush toilet, but it is likely that as the market for composting toilets expands, economies of scale will kick in and the price will go down.

It is unrealistic to expect a new technology like composting toilets to be a) perfect, and b) cheap. History has shown that as new technologies become more widely accepted and used, their performance improves and their price declines.

There is a positive side to the extra maintenance associated with a composting toilet as opposed to a flush toilet. Ownership of a composting toilet entails awareness of one's body wastes, a greater sense of responsibility for that waste, and demonstrates the connections between people and the natural systems of the earth. The changes in social attitudes which are now being manifested in eagerness to recycle cans, bottles, and paper, may transform the extra effort associated with composting toilets from a drawback to an attractive, rewarding activity.

Composting Toilet Owners Survey

In May 1989 a small survey was conducted on a (nonrandom) sample of identified owners of composting toilets. This was intended to be a reality check on the claims of toilet manufacturers; to see how the devices behaved in real life. Names and addresses were provided by the Sun-Mar Corporation of Burlington, Ontario. They were people in Ontario who had purchased composting toilets from Sun-Mar for use in seasonal homes in rural areas. Because the sample was not randomly selected, and also

because of its small size, the results of this survey cannot be extrapolated to other owners of composting toilets. Twenty one questionnaires were sent out and 14 were returned.

We asked respondents to describe any problems which they had encountered in their ownership and use of a composting toilet. Twenty-nine percent reported no problems at all. Offensive odours were mentioned by 21% (3) of the respondents. Of these people, one said that the odour was mild while another specified that it had only occurred once. Defective parts were a problem for 29% of the respondents, with the fan being the most common problem. Overfilling of the sewage retention tank was a problem for 21% of the owners.

We also questioned respondents on the advantages of the composting toilet. All respondents agreed that requiring no septic system was an advantage. 36% acknowledged that savings on water and sewage bills was evident. 64% believed the composting toilet to be advantageous in that it is an environmental solution to sewage disposal. The compost produced was perceived as an advantage by 29% of the respondents.

The disadvantages of these toilets were also considered. 29% of the respondents saw no disadvantages to these toilets. Emptying the tray was seen as a disadvantage by 43% of the owners. Only 7% cited the do-it-yourself installation as a disadvantage. Rotating the biodrum (composting chamber) by means of a hand crank frequently was perceived as a disadvantage by 36%. One composting toilet owner of more than six years remarked, "...very satisfied with our (composting toilet) -- it has a few minor drawbacks, however, life does, too!"

To sum up their feelings towards composting toilets, we asked the owners if they would recommend them for use in permanent, year-round homes. 43% of the respondents did recommend composting toilets for permanent homes; 36% did not; and 21% were unsure. Two of the unsure owners mentioned only a capacity problem and the third responded that "if the design of the toilet was modified slightly it would be excellent."

Survey of Homeowners in the Hamilton-Burlington area

Methodology

The target population of this survey was homeowners in the Hamilton/Burlington area. The sample was selected from voter lists for Hamilton, and from telephone directories for Burlington, Stoney Creek, Ancaster, and Dundas. The sampling method was systematic random in which a random number table was used to determine the starting point. Every "nth" address was taken from that point in proportion to the population size of each community. Addresses which appeared to be apartments (i.e. those with an

apartment or unit number as part of the street address) were eliminated from the sample, since homeowners were the type of respondents sought.

The survey was carried out by means of a self-administered mail questionnaire. 1200 questionnaires were sent to a randomly-selected sample of house-dwellers. Follow-up thank you notes were sent a week later. 329 questionnaires were returned, representing a response rate of 27%. This was deemed satisfactory since many mail surveyors consider a 15 to 20% response rate to be a good return.

The questionnaire and complete results of the survey are contained in Appendix A. In addition, many respondents provided handwritten comments on the questionnaire, and a representative sample of these is included in Appendix B.

General Attitudes About the Environment and Hamilton Harbour

Respondents were asked to rate their level of concern about the present state of the environment on a scale from 1 to 5, with 1 meaning not concerned and 5 meaning extremely concerned. The majority (59%) placed themselves at the top of the scale, and 29% placed themselves at the 4 level. Not a single respondent checked the 1 level (indicating no concern).

Respondents perceive Hamilton Harbour to be very polluted. On a scale from 1 to 5, with 1 meaning not polluted and 5 meaning very polluted, 55% of respondents gave Hamilton Harbour a 5 and 33% gave it a 4. There was also general agreement on the need to improve the water quality of the Harbour. On a similar scale of 1 to 5, with 1 meaning no need for improvement and 5 meaning a large need, the majority (73%) responded with a 5, and 22% with a 4.

Most respondents do not feel that actions to date have been very adequate in dealing with environmental problems. On a scale from 1 to 5, with 1 meaning inadequate and 5 meaning very adequate, the majority (65%) responded with a 2 or less.

In response to the question, "How much change do you think will be necessary in our society in order to solve our environmental problems?", the majority (72%) feel that a considerable amount of change is needed. A further 22% feel that a completely new social system is needed in order to solve our environmental problems. These results indicate a general feeling that social change is recognized as part of the solution to environmental problems. Analysis revealed a significant relationship between this variable and the level of concern about the state of the environment. People who are extremely concerned about the environment are more likely to believe that a whole new social system is needed (26%) than people who are moderately

concerned (8%).

Behaviours

Results of this survey indicate a high level of participation in household recycling (blue box) programs. 57 percent of the respondents always recycle ; 25 percent do it most of the time; 12 percent sometimes; and only 6 percent say that they do not recycle. The overwhelming majority, 96 percent, feel that their community recycling program is worth the cost and effort involved.

Composting yard and kitchen waste is not as popular as recycling cans, bottles, and newspapers, but this behaviour is practiced by 28 percent of the respondents.

This survey also revealed environmentally conscious behaviour in the form of water conservation, with 78% of the respondents reporting that they try to conserve water. In addition to this, 34 percent have minimum-flow fixtures in their residences. People who try to conserve water are more likely to say that they would use minimum-flow fixtures than those who do not conserve water.

Recreational Use of Hamilton Harbour

30 percent of the respondents report use of Hamilton for recreation. The proportions of respondents who use the Harbour for different types of recreation are shown in Table 1 , as well as the percentages who would participate in the various forms of recreation if water quality was improved. Based on this data, present water quality in the Harbour is an important constraint to recreational use of the Harbour.

Table 1. Present and Future Recreational Use of Hamilton Harbour

Type of Recreation	Participation Rate Present Conditions	Participation Rate Improved Water Quality
Boating	13%	26%
Fishing	6%	36%
Swimming	0%	47%
Birdwatching	9%	16%
Sailing	9%	13%
Windsurfing	1%	8%
Other	8%	4%

Willingness to Pay

This survey contained several willingness-to-pay questions. The first asked how large a tax increase respondents would be willing to pay if the additional revenues were used to clean up Hamilton Harbour. The majority of respondents (80%) are willing to pay additional taxes for this purpose. The actual amounts vary: 26% would pay $1-$49/yr; 33% would pay $50-$99/yr; 15% would pay $100-$299/yr; 2% would pay $300-$499/yr; and 4% would pay $500 or

more/yr. Analysis of the survey data revealed that people who perceive a large need to improve the water quality in the harbour are more likely to accept additional taxes in order to pay for a cleanup.

A majority of the respondents are also willing to pay for minimum-flow fixtures in their homes. However, support for increased water and sewage rates is not very high. 30% of the respondents feel that the current water/sewage rates are already too high; 50% feel that they are about right.

Feelings About Composting Toilets

Most people are not sure about using composting toilets on a regular basis. This is not surprising, since most people are not familiar with these devices, and many probably had never heard of them until they received our questionnaire in the mail. Nevertheless, after reading a brief description of a composting toilet and how it works, 23 % of the respondents say they would consider using one on a regular basis; 26 % say no; and 51% are unsure.

Acceptability of composting toilets is directly and significantly related to the level of concern about the environment. People who are more concerned about the environment are more likely to try composting toilets. Statistical analysis also revealed significant relationships between age and willingness to use composting toilets. People who are ready to try composting toilets tend to be younger than those who are not. The highest level of acceptance is in the 31-40 year age group. These are people who have grown up with the environmental movement.

Results of this survey indicate that a gradual shift from conventional flush toilets to composting toilets is more acceptable than an abrupt change. When asked if they would consider owning a composting toilet in a second washroom in their home, 36% say yes, 22% say no, and 42% are still unsure.

An even higher percentage, (40%) would consider buying a new house in which a composting toilet has been installed. Men are more willing to purchase a new home with a composting toilet than are women (46% vs. 32%).

The extra maintenance associated with ownership and use of a composting toilet is seen as a problem by a majority of the respondents (68%). Having to empty the tray periodically is a concern for 50% of the respondents. Spreading the compost on a garden is a concern for about a quarter of the respondents. 44% of the respondents feel that a compost collection program similar to that of curbside recycling would make disposing of the compost more acceptable. Half of the respondents feel that having to add kitchen scraps or peat moss to the toilet occasionally would be an

inconvenience; the other half think that it would be useful in terms of reducing household waste.

Half of the respondents perceive that the use of composting toilets would result in significant long term savings on water and sewage charges. However, the current cost of a composting toilet ($1200-$1500) is a large barrier to individuals who may want to shift. After reading information about the current costs of composting toilet, only 5% of the respondents said that they would consider buying one for a second washroom in their home in the near future. This percentage is considerably less than in the earlier questions (where cost was not a factor).

Socio-economic characteristics of the respondents

The socioeconomic characteristics of the respondents to this survey are not representative of the general population because the population from which the sample was drawn was not the general public, but people who live in houses as opposed to apartments (see methodology section above). The majority of the respondents were house owners as well as house dwellers (94%). Statistics on the age, education, and income of homeowners in Ontario are not readily available, but in view of the high cost of home ownership in the Hamilton/Burlington area, one would expect relatively high incomes. This is the case in our sample, with 40% having annual family incomes of $50,000 or more. Education levels among respondents are also quite high, with 65% having post-secondary education. This is also to be expected, since higher education levels are related to higher income levels. The age distribution of respondents is shown in Appendix A. Males are overrepresented in this survey (59%), as compared to females (41%).

Conclusions

The idea of using composting toilets as a remedial option, a way of improving water quality in Hamilton Harbour, has been explored from several angles. If even 10% of the households in the Hamilton/Burlington area were to use composting toilets, there would be a substantial reduction in nutrient loadings to the municipal sewage treatment plants, and to the harbour. Nitrogen entering the sewage system would be reduced by 270 tonnes/yr. and phosphorus would be reduced by 90 tonnes/yr. Composting toilets could also generate significant benefits in the area of water conservation.

From a technical and economic standpoint, composting toilets are neither a) perfect, nor b) cheap, but history has shown that new technologies rarely are. Witness the first automobiles, which were unreliable mechanically, and only affordable for the rich. Ditto with computers. As these technologies became more widely used, performance improved, and cost went down. A review of the literature on composting toilets shows that the performance

improvement part of this process is already happening. New designs and models of composting toilets perform much better than those that were introduced in the 70's and early 80's. Direct costs to the homeowner are still higher than conventional flush toilets, but will likely go down significantly as composting toilets are more widely used, due to economies of scale.

In terms of social acceptability, results of the survey indicate that nearly a quarter of the homeowners in the Hamilton/Burlington area would consider installing a composting toilet in their home. 26% would not consider it; and 51% are not sure. A portion of these unsure respondents would likely accept composting toilets in the future if they knew more about them. Acceptability of composting toilets is directly and significantly related to the level of concern about the environment. People who are more concerned about the environment are more likely to try composting toilets. This is a very encouraging connection, because public concern about the environment is likely to remain high in the future.

Recommendation

It is recommended that a Demonstration Project on composting toilets be carried out as soon as possible. The site could be any one of the Areas of Concern. A group of citizen volunteers would be the core of the project. An agreement would be made with each citizen that they would be provided with a composting toilet, either at no cost or a nominal fee, on the condition that they agree to participate in the project for a specified length of time (one or two years). Volunteers would keep records on their toilets performance, and also on family, visitors, and neighbors' reactions. Such a project would accomplish several objectives. It would be a test of the viability of composting toilets in an urban setting (most current use is in rural areas). It would also be an educational vehicle, not only for the participants, but through media coverage, for the broader public.

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APPENDIX A

QUESTIONNAIRE AND RESULTS OF SURVEY

1.1 How concerned are you about the present state of the environment?

		Frequency	Percentage
1	(not concerned).....	0	0%
2	.....	3	1%
3	.....	35	11%
4	.....	94	29%
5	(extremely concerned).....	192	59%

Valid Cases 324 Missing Cases 5

1.2 How much change do you think will be necesary in our society in order to solve our environmental problems?

There is no environmental problem.....	0	0%
No basic change is needed to solve these problems.	3	1%
A considerable amount of change is needed to solve these problems.....	233	72%
A completely new system is needed.....	73	22%
Change is needed but unattainable.....	17	5%

Valid Cases 326 Missing Cases 3

1.3. How adequate do you think that actions to date have been in dealing with environmental problems?

1 (inadequate).....	90	28%
2	122	37%
3	83	26%
4	21	6%
5 (very adequate).....	10	3%

Valid Cases 326 Missing Cases 3

1.4 How often do you participate in household recycling?

1 (never).....	13	4%
2	07	2%
3	38	11%
4	81	25%
5 (always).....	186	57%

Valid Cases 325 Missing Cases 4

1.5 Do you feel that a recycling program in your community is worth the cost and effort involved?

yes	315	97%
no	8	3%

Valid Cases 323 Missing Cases 6

1.6 Do you compost your yard and kitchen scraps?

yes	90	27%
no	237	73%

Valid Cases 327 Missing Cases 2

1.7 Please check your type of residence.

house	319	97%
townhouse	10	3%

Valid Cases 329 Missing Cases 0

1.8 Do you rent your or own your place of residence?

own	310	94%
rent	19	6%

Valid Cases 329 Missing Cases 0

2.1 How polluted do you perceive Hamilton Harbour to be?

1 (not polluted)	1	.
2	2	1%
3	36	11%
4	104	33%
5 (very polluted)	177	55%

Valid Cases 320 Missing Cases 9

2.2 How much of a need is there to improve the water quality in the Harbour?

1 (no need)	1	.
2	2	1%
3	15	5%
4	69	22%
5 (large need)	233	73%

Valid Cases 320 Missing Cases 9

2.3 What do you perceive as the most significant pollution problem(s) in the Harbour? Check all that apply.

Municipal Sewage	254	77%
Industrial Wastes	315	96%
Water clarity	97	30%
Access to Harbour	49	15%

2.4 If money to clean up the Harbour was to be obtained from government tax revenue, how large a tax increase would you be willing to accept, per year?

$0	58	20%
1-49	77	26%
50-99	98	33%
100-299	45	15%
300-499	6	2%
500+	12	4%

Valid Cases 296 Missing Cases 33

2.5 Do you use the Harbour for recreation?

yes	29	9%
no	229	70%
sometimes	68	21%

Valid Cases 326 Missing Cases 3

2.6 If yes, for what type of recreation? Check all that apply.

Boating	42	13%
Fishing	19	6%
Swimming	0	0%
Bird Watching	29	9%
Sailing	29	9%
Windsurfing	3	1%
Other	27	8%

2.7 If the water quality of the Harbour improved, what type of recreation would you participate in? Check all that apply.

Boating	84	26%
Fishing	117	36%
Swimming	156	47%
Bird Watching	53	16%
Sailing	41	13%
Windsurfing	27	8%
Other	13	4%

3.1 Do you try to conserve water?

yes	255	78%
no	71	22%

Valid Cases 326 Missing Cases 3

3.2 Do you use minimum-flow fixtures?

yes	113	35%
no	214	65%

Valid Cases 327 Missing Cases 2

3.3 If yes, what type do you use?

Dishwasher	32	10%
Shower	90	27%
Clotheswasher	48	15%
Toilet	35	11%
Faucet	37	11%

3.4 If no, are you aware of the availability of minimum-flow fixtures?

Yes	61	28%
No	157	72%

3.5 Would you use minimum-flow fixtures?

Yes	181	85.0%
No	32	15.0%

Valid Cases 213 Missing Cases 116

3.6 If yes, what type would you use?

Toilet	146	44%
Shower	116	35%
Dishwasher	101	30%
Clotheswasher	130	40%
Faucet	139	42%

3.7 Which of the following potential problems do you foresee in using minimum-flow fixtures?

Availability	97	30%
Maintenance	69	21%
Education	229	69%
Higher costs	126	38%
Lack of government funding	66	20%

3.8 How much would you be willing to spend on minimum-flow fixtures for your house to aid in reducing water use and pollutant loadings to the Harbour?

$0-19	65	23%
20-49	79	28%
50-99	79	28%
100+	57	20%

Valid Cases 280 Missing Cases 49

3.9 Research has shown that the most effective way to reduce water use is through increased water prices. Would you support an increase in water rates for all users if this resulted in a cleaner and healthier Harbour?

yes	108	35%
no	123	40%
depends	76	25%

Valid Cases 307 Missing Cases 22

3.10 If yes, how much more would you be willing to spend on water and sewage rates, per month, to aid Harbour clean-up?

$0-9	77	48%
10-19	39	25%
20-29	24	15%
30-39	7	4%
40+	12	8%

Valid Cases 159 Missing Cases 170

3.11 Do you have a water meter?

yes	194	61%
no	123	39%

Valid Cases 318 Missing Cases 11

3.12 How much do you currently pay (monthly) for water?

$0-19	90	44%
20-49	83	40%
50-99	27	13%
100+	6	2%

Valid Cases 206 Missing Cases 123

3.13 Do you feel the current water/sewage rates are too high?

yes	79	30%
no	51	20%
about right	131	50%

Valid Cases 261 Missing Cases 68

THE COMPOSTING TOILET

3.14 Would you consider using one of these toilets on a regular basis?

yes	75	23%
no	83	26%
not sure	165	51%

Valid Cases 323 Missing Cases 6

3.15 Do you feel that the extra maintenance would be a problem in owning one of these toilets?

no problem	66	21%
somewhat a problem	164	52%
major problem	51	16%
no opinion	37	12%

Valid Cases 318 Missing Cases 11

3.16 What concerns do you have about disposing of the composted soil-like material produced?

No concerns	83	25%
Emptying the tray	163	50%
Spreading compost on flower garden	75	23%
Spreading compost on vegetable garden	85	26%

3.17 Would a compost collection program similar to that of recycling make disposing of the compost more acceptable?

yes	136	44%
no	55	18%
not sure	121	39%

Valid Cases 312 Missing Cases 17

3.18 How much long term savings on water and sewage charges do you perceive through use of the composting toilet?

no savings	28	10%
minimal savings	114	41%
significant savings	117	42%
substantial savings	22	8%

Valid Cases 281 Missing Cases 48

3.19 The composting toilet requires organic kitchen scraps and/or peat moss to be added to assist in decomposition. Do you see this requirement as:

useful in terms of reducing household waste	150	49%
a minor inconvenience	99	32%
a major inconvenience	58	19%

Valid Cases 307 Missing Cases 22

3.20 If the opportunity arose, would you consider owning a composting toilet in a second washroom in your home?

yes	113	36%
no	68	22%
not sure	130	42%

Valid Cases 311 Missing Cases 18

3.21 If you were moving into a new home, would you consider a house in which a composting toilet has been installed, replacing a regular sewer system?

yes	126	40%
no	56	18%
not sure	134	42%

Valid Cases 316 Missing Cases 13

3.22 The cost of a composting toilet currently ranges from $1200-1500. Would you consider buying one for a second washroom in your home in the near future?

yes	14	5%
no	189	60%
not sure	110	35%

Valid Cases 313 Missing Cases 16

3.23 If no, how much would you consider spending on a composting toilet for your house to aid in reducing sewage loadings from the Hamilton area?

$0	89	41%
1-49	11	5%
50-99	16	7%
100-199	38	17%
200-499	49	22%
500-999	14	6%
1000-1200	2	1%

Valid Cases 219 Missing Cases 110

DEMOGRAPHICS

4.1 Sex

male	183	59%
female	128	41%

Valid Cases 311 Missing Cases 18

4.2 Age

<21	3	1%
21-30	50	16%
31-40	76	24%
41-50	71	23%
51-60	53	17%
61+	59	19%

Valid Cases 312 Missing Cases 17

4.3 How many years of formal education have you completed?

5-8	15	5%
9-12	92	30%
13-16	120	39%
17 and up	81	26%

Valid Cases 308 Missing Cases 21

4.4 Total Yearly Family Income:

<10000	12	4%
10-19999	27	10%
20-29999	39	14%
30-39999	47	17%
40-49999	43	15%
50000+	111	40%

APPENDIX B
A Representative Sample of Comments

"The harbour should be cleaned up asap at whatever cost. Water pollution is a national disgrace, particularly Hamilton Harbour. Industrial waste cleanup should be paid for by industry, not by the taxpayer. I think it will take a long time to sell the concept of a composting toilet."

"The composting toilet and minimum flow fixtures are new to me and I agree every one must share in cleaning our environment. At the same time some have shown great profit by their callous approach to waste disposal and the governments (all levels and parties) have conveniently turned a blind eye. Now it is time to bite the bullet and the heavy polluters must pay the lion's share of the cost because they have already stollen the lion's share of the profit."

"...new waste disposal ideas that aren't directly in our homes thru the new 'outhouse' idea. We don't have the physical stamina to compost a damn toilet. Perhaps my future grandchildren can zap their toilets with a 'ray handle' that will dissolve waste on the spot, kind of space-like."

"I feel water conservation is a very necessary policy for today's society. It would seem to me that education of the public for the need to conserve water is the first place to start. Unless a person understands why one should conserve, and how one should conserve, they will not accept new policies. I also feel very strongly that industrial waste, deposited into the bay should be controlled more strictly. Pollution control laws need more teeth and rigid enforcement. People will not be willing to pay large amounts of money for composting toilets to preserve the bay of pollution while industry continues."

"These types of changes require a whole new 'rethinking' of the way we view our waste. Changes without educating and making residents aware of the fact that waste is a personal responsibility of the future and less of a free service to be taken for granted, is, in my view, a bandaid at best. This is a program that people must want to put into action as a logical solution for the future. It must become the 'in' thing of the 90's. It must be seen as an improvement in lifestyle, to save the future maybe, but certainly must be seen as a personal choice of responsible people."

"I grew up in a small town. Outside toilets, honey wagons were part of my life. Compost was always necessary for our gardens. When I moved to the city my parents still composted all scraps, washed bottles and cans and put them in a box outside for garbage pickup. That was in the early 1940's. When I got married my husband and I did the same. Some of the neighbours complained about the smell and you were threatened that you would be reported to the board of health if you continued to do this. We

do not have a garden and we do not have much waste scraps, etc. At my age I do not want to have a composting toilet. To change our faucets, etc. no. The cost and inconvenience is a burden. The newer homes should have had this put in years ago. The younger generation should be more concerned about our environment and take a larger part in helping to solve it. They take too much for granted, things are so convenient for them and have to be educated about these problems. I feel we pay enough taxes and have all our lives that we should not have to carry this burden as seniors. We have done our part to conserve and do without."

Comment from a respondent who answered 'not sure' to all composting toilet questions:

"We are really in favour; it's a great thing. We are all for composting as we already put this idea into form in our garden with kitchen wate. We feel the government should help financially though even if they do take it back with the other hand. It still looks good, and will likely draw upon another 40 to 50% of environmental concerned people. We are seniors and we would perhaps need help as we get older in spreading the compost around our garden."

"Having grown up recycling compost, it is very acceptable to me. Why can't we have a compost pail which goes out with the blue box. Even though I live in a single family residence, I do not have the space for a proper compost pile. Multi unit dwellings should have a separate garbage chute for composting materials."

"If you are trying to encourage the use of composting toilets the following are needed: 1) significant amounts of education; 2) increase in water prices; and 3) significant rebate for area residents on the price of composting toilets. The rebates could be generated from the increase in water fees."

"Money, Money, Money. Incentives for those who try; fines for those who don't care."

"If we could clean up the harbour substantially by using these toilets then it should be made compulsory with gov't assistance aiding with the expense. New home builders should have to put these toilets in. Everyone should have to conform. (Communism?) The pollution will end up killing us all. Do something to help. We, the homeowner, should be fined for not recycling, for not being conscious and aware of ways to help our community, together, control pollution. Thanks for being so concerned."

"Major industries would have to clean up first. It's much more damaging than residential homes."

"I would have to be convinced that the composting toilet had no odour and its style was modern and completely compatible with a modern bathroom and it appears and is as clean. What about the added electrical cost to me and also the environmental harm of

producing the extra electricity or other heat source?"
"A substantial marketing campaign would be necessary to 'sell' the concept of composting toilets, but the use of same will become, or is, essential. Canadians are so wasteful, and it is time that we learned alternative ways."

"Although aware of the environment, I feel lack of information does not allow people to know about these devices. (i.e. composting toilets, water restrictors) If people could incorporate these items and know the capability and service savings the environment would clean up. The cost at rising inflation and taxation would be the sole negative factor."

"Much more information is required. You asked questions which most persons could not answer unless you would make available 1) more information; 2) very good reasons to spend money; and 3) consider government subsidies."

"Have never heard of the composting toilet. Would have to understand more to really make a decision. Adding compost to the garden soil has never been a problem. Have always loved gardening, but further education is necessary on this."

"Maybe such toilets could be introduced into the work place, thus giving us a chance to get used to this new idea gradually. I'd like to help, but $1500 -$2000 is a lot to put out. "

" Composting toilets will require a great amount of public education. I might consider one myself, but would hesitate to offer it as the only alternative for visitors to my home."

"Have tried chemical and composting toilets at cottage, with not too much success. Odour, maintenance when parts started rotting out on toilet, etc."

"Have previously tried composting toilet (20 some odd years ago) , not satisfactory."